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54. Title of Invention: Electrophoretic Display Device

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72. Inventor: Osamu[1] Inoue
Minami Ibaraki Plant, Nihon Mectron Co., Ltd.[2]
757 Amaboki, Kukizaki-machi, Inashiki-gun, Ibaraki-ken

72. Inventor: Akira[3] Tadakuma
Minami Ibaraki Plant, Nihon Mectron Co., Ltd.*
757 Amaboki, Kukizaki-machi, Inashiki-gun, Ibaraki-ken

72. Inventor: Takashi[4] Mori
Minami Ibaraki Plant, Nihon Mectron Co., Ltd.*
757 Amaboki, Kukizaki-machi, Inashiki-gun, Ibaraki-ken

72. Inventor: Naoyuki[5] Maida
Minami Ibaraki Plant, Nihon Mectron Co., Ltd.*
757 Amaboki, Kukizaki-machi, Inashiki-gun, Ibaraki-ken

71. Applicant: Nihon Mectron Co., Ltd.*
1-12-15 Shiba Daimon, Minato-ku, Tokyo

74. Agent: Akimitsu Kamata, Patent Attorney

Specification

1. Title of the Invention

Electrophoretic Display Device

2. Claims of Patent

(1) An electrophoretic display device wherein the space between a pair of opposing electrode plates at least one of which is transparent is filled with a disperse system containing electrophoretic particles, and the state of distribution of the electrophoretic particles in the disperse system is changed under the action of a display-

[1] ILS Note – An alternative way of reading this personal name is Shu.
[2] ILS Note - Despite an exhaustive search of available resources, we were unable to verify the Official company name. Phonetic translation is provided. Hereafter denoted as *.
[3] ILS Note – Alternative ways of reading this personal name are Akashi, Sho, and Teru.
[4] ILS Note – An alternative way of reading this personal name is Koshi.
[5] ILS Note – Alternative ways of reading this personal name are Takashi and Hisayuki.

controlling voltage applied across said electrodes in order to change the optical reflection properties and thereby to induce a specific display operation; in which are provided numerous microcapsules filled with a disperse system in which is dispersed, in a colored dispersion medium, at least one kind of electrophoretic particles the optical characteristics of which differ from those of said dispersion medium; with said device configured such that these microcapsules are arranged between the abovementioned electrode plates.

(2) An electrophoretic display device of Claim (1) of the present invention, wherein the volume resistivities of the abovementioned disperse system and microcapsules are for practical purposes the same.

3. Detailed Explanation of the Invention

(Field of Industrial Application)

The present invention concerns a display device utilizing electrophoretic particles; more precisely, it concerns an electrophoretic display device in which individual microcapsules are filled with a disperse system in which electrophoretic particles are dispersed in a dispersion medium, and these microcapsules are placed in the space between electrode plates.

(Prior Art and Problems Therewith)

In this type of electrophoretic display device using electrophoretic particles, the space between a pair of opposing electrode plates at least one of which is transparent is filled with a disperse system in which electrophoretic particles are dispersed in a liquid dispersion medium, and the electrophoretic particles in the dispersion medium are made to adhere to or be repelled from the transparent electrode plate side according to the polarity of said electrode plates, so that by controlling said polarity, any desired characters, symbols or figures can be displayed. As the liquid dispersion medium used in the disperse system, an alcohol solvent, various esters, aliphatichydrocarbons, alicyclic hydrocarbons, aromatic hydrocarbons, halogenated hydrocarbons, or various other hydrocarbons may be used either individually or in an appropriate mixture, with a surfactant added in an appropriate quantity. As the electrophoretic particles, carbon black, iron blue[6], phthalocyanine green, and other materials are known as general-use materials.

Figure 2 is a conceptual cross-sectional diagram of the main components of the electrophoretic display device in question. Here 1 and 2 are respectively glass sheets or some other transparent material, and transparent electrodes formed in the required pattern on one side; the space between this pair of transparent electrodes 2, placed to oppose each other, is filled with a disperse system 10 containing electrophoretic particles. In a construction in which the disperse system 10 simply fills the space between the electrodes, coagulation of the electrophoretic particles and adhesion phenomena may cause display unevenness; as methods of preventing such occurrences, constructions are known in which mesh-shaped spacers[7] 9 with numerous holes of an appropriate shape 9A as shown in Fig. 3, or perforated spacers 9 with numerous penetrating holes, are placed between the two electrodes 2, in order to divide the disperse system 10 into discontinuous areas and thereby stabilize the display operation.

In an electrophoretic display device provided with said perforated spacers 9, after placing said perforated spacers 9 between both transparent electrodes 2, each of the penetrating holes 9A formed in the perforated spacer 9 is filled with the disperse system 10; however, it is extremely difficult to uniformly fill the numerous penetrating holes 9A with the disperse system 10. One method which may be considered is to drip the disperse

[6] ILS Note – Alternative translations for this term are "Milori blue" and "navy blue."

[7] ILS N te – Although we have assumed that this term is plural, the Japanese text does not explicitly state whether multiple spacers are used.

system 10 onto or apply the disperse system 10 to each of the penetrating holes 9A after the perforated spacers 9 are formed on one of the transparent electrodes 2; but the dispersion media generally used in the disperse system 10 are easily vaporized, so that when using this method the characteristics of the disperse system 10 change and it is difficult to maintain reproducibility.

(Purpose of the Invention and Constitution)

Instead of using the above-described perforated spacers or similar parts, the present invention employs a method in which the disperse system is enclosed in microcapsules in advance. By this means an electrophoretic display device is offered in which the various above-described problems relating to the disperse system filling the space between transparent electrodes are satisfactorily eliminated, the process of inserting the disperse system is simplified, and good-quality electrophoretic display operation, including display of arbitrary colors, can be achieved reliably.

In order to attain this goal, in the electrophoretic display device of the present invention, the space between a pair of opposing electrode plates at least one of which is transparent is filled with a disperse system containing electrophoretic particles, and under the action of a voltage for display control which is applied across said electrodes, the distribution states of the electrophoretic particles within the dispersive system are changed, to alter the optical reflection properties and induce so-called display operation; and in this device are formed numerous microcapsules, which are filled with a dispersive system consisting of a colored dispersion medium in which are dispersed at least one type of electrophoretic particle with optical properties differing from said dispersion medium, with said microcapsules arranged between the abovementioned electrode plates. Here it is desirable that the volume resistivities of the abovementioned dispersive system and the microcapsule film are practically equal.

(Embodiment)

The present invention is explained in further detail below, referring to the embodiment shown in Fig. 1. In the figure, numerous microcapsules 3, each filled in advance by a microcapsule process with a disperse system 5 in which electrophoretic particles 4 are dispersed in a dispersion medium, are placed between the transparent electrodes 2 formed on the opposing surfaces of a pair of transparent sheets consisting of glass sheets or some other material. Here, the electrophoretic particles 4 of the disperse system 5 used to fill the microcapsules 3 may be, in addition to well-known colloidal particles, various other organic or inorganic pigments, dyes, metal powders, glass, resin or other fine powders, as appropriate. As the dispersion medium of the dispersive system 5, in addition to water, alcohols, hydrocarbons and halogenated hydrocarbons, various natural or synthesized hydrocarbons may also be used. To this dispersive system 5 may be added, as necessary, electrolytic materials, surfactants, metal soaps, resins, rubbers, hydrocarbons, varnish, compounds, and other charge-controlling agents consisting of particles, as well as dispersive agents, lubricants, stabilizing agents and other materials. Moreover, in addition to unifying the electric charge on the electrophoretic particles 4 undergoing electrophoresis at positive or negative charges and employing measures to raise the zeta potential or uniformly stabilize the dispersion, the adhesion to the transparent electrodes 2 of the electrophoretic particles 4 or the viscosity or other properties of the dispersion medium may be adjusted as appropriate.

The disperse system 5 with this composition is mixed thoroughly using a ball mill, sand mill, paint shaker or other appropriate means, and then a suitable method, such as interfacial polymerization, insolubilization reaction, phase separation, or interfacial precipitation, is used to enclose the disperse system 5 in microcapsules. Here, it is desirable that the volume resistivities of the film of the microcapsules 3 and the disperse system 5 be for practical purposes the same.

Microcapsules 3 obtained by this means are arranged on one of the transparent electrodes using a roller printing technique, a spray technique or some other method, and this may then be combined with the other transparent electrode 2 to fill the space between the two electrodes 2 with the microcapsules. In addition to the above means of filling the space between the electrodes 2 with the disperse system 5 using microcapsules 3, a method can also be employed in which appropriate filling holes linking the two electrodes are used to inject appropriate quantities of microcapsules 3.

In addition, for practical purposes it is desirable that the gaps between microcapsules 3 and the gaps between electrodes 2 and microcapsules 3 be filled via injection holes 6 with a material 7 which is chemically stable with respect to the microcapsules 3, and has for practical purposes the same refractive index and volume resistivity, as shown in Fig. 1. Here 8 denotes end sealing material.

(Effects of the Invention)

In an electrophoretic display device of the present invention, as has been described, the disperse system is encapsulated in microcapsules in advance, and these microcapsules are arranged in a plane between the electrodes used for display control. Consequently, there are at least the following advantageous results.

Because the composition of the disperse system in microcapsules is maintained to be uniform, coagulation of the electrophoretic particles or adhesion to the electrodes as in devices of the prior art are eliminated, and uniform and stable display operation is possible.

The device is constructed such that microcapsules are arranged between the electrodes used for display control, so that handling of the disperse system and processes for filling the space between the electrodes with the disperse system during assembly can be greatly improved without the need to consider adverse effects on the disperse system, to obtain an electrophoretic display device with satisfactory characteristics.

In encapsulating the disperse systems in microcapsules in advance, it is possible to produce disperse systems with various display colors, and appropriately arrange microcapsules with these different display colors to configure a desired color display; in doing so, no barrier walls or means of partitioning are needed.

4. Brief Explanation of the Drawings

Figure 1 is a conceptual cross-sectional diagram of the main components of an electrophoretic display device provided with microcapsules filled with a disperse system, according to the Embodiment of the present invention;

Figure 2 is a conceptual cross-sectional diagram of the main components of an electrophoretic display device of the prior art, provided with perforated spacers; and,

Figure 3 is a partial explanatory isometric diagram of an example of the construction of a perforated spacer.

1: Transparent material
2: Transparent electrode
3: Microcapsule
4: Electrophoretic particles
5: Disperse system
9: Perforated spacer
10: Disperse system

図 1

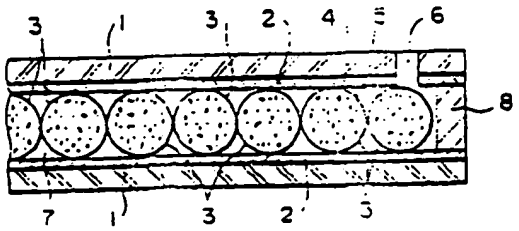

図 2

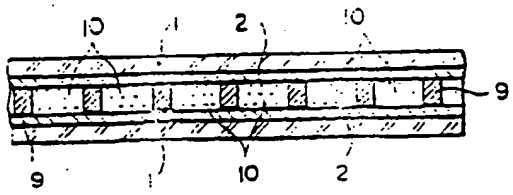

図 3